Electrophysiological response of the central nervous system to prolonged visual stimulation in migraine

Migraine is a paroxysmal disorder with complex symptoms (prodromal stage (aura), headache phase, post-paroxysmal phase) by nature it is primarily a dysfunction of the central nervous system with the absence of structural changes discernible on routine neuroradiological imaging. A part of the so far elusive pathophysiology of migraine, is the abnormal central processing of sensory information that has both clinical (in visual perception i.e. photophobia) as well as electrophysiological correlates. In the last three decades, the development of fundamental research in the neurophysiology of central neurogenic dysfunction in migraines (where visual evoked potentials VEP play a pivotal role), has been accompanied by numerous debates on the contradictory findings suggestive of cortical hyperexcitability or hypoexcitability. In order to unify the concept, it would be appropriate to refer to migraineurs as having cortical hyper-responsibility, which implies an increased sensitivity to facilitatory or inhibitory stimuli. The discrepancies in electrophysiology findings gradually grew in number and a significance towards a migraine specific electrophysiological abnormality emerged – a deficit in decrement amplitude response (referred to as habituation deficit) i.e. a cyclical fluctuation in the presence of a habituation deficit (habituation deficit cease in the ictal and early preictal periods). Deficit habituation in migraine has been associated with thalamo-cortical disconnections (dysrhythmias), and is likely to imply a loss of the brain's physiological protection against sensory stimuli "overload", which may play a role in triggering the "cortical spreading depression" like phenomenon – this can be noted as the main benefit of electrophysiology studies in understanding the pathophysiology of migraine. Although there are reports in literature regarding abnormal motion processing in migraine, and even predilection alteration in the processing of a motion visual stimuli, as of yet the use of motion VEP stimulus for the study of habituation in migraine has not been documented. The inspiration for our own experiment, and its blinded evaluation, was a study that showed no habituation deficit in the interictal period in migraineurs.

As part of the actual experiment, a VEP method was developed to facilitate the evaluation of amplitudes of evoked responses over time (5 blocks of VEP of 60 responses) to 3 types of visual stimulation (reversal stimulus with high and low contrast and a motion stimulus) over a period of 2.5 minutes (linear trend of amplitude over time in μV/min, amplitude ratio 5:1). Varying types of visual stimulation served to study different parts of the visual system up to the visual cortex (primary visual cortex using reversal stimuli and the extrastriatal regions using motion stimuli). The results in 39 patients with migraine (compared to 36 healthy volunteers), specifically in 19 migraine patients who were examined in the interictal phase, supported the existence of a deficit in VEP amplitude decrement during prolonged visual stimulation in migraineurs. Although anticipated, no significant VEP decrements were observed in the group of 10 migraine patients in ictal phase and 10 on prophylactic treatment, however, a decremental trend in certain parameters was noted when statistical comparisons were done between the groups. A deficit in VEP amplitude decrement was observed when using the reversal stimulus with high contrast and in response to onset of motion during the motion stimulus. This proved that the alteration in processing visual stimuli in migraineurs is not only bound to the primary sensory regions (primary visual cortex), but also involves secondary cortical areas (extrastriatal visual cortex). Contrary to expectations, low-contrast visual stimuli was not found to be advantageous in evoking a decrement in VEP amplitudes. The experimental protocol provided relatively simple algorithms that can be used to blind the evaluation process. The results are presented acknowledging the limitations regarding the definition of the term habituation (lack of differentiation from sensory adaptation and fatigue) thus making the preferred term decrement (amplitude VEP).